



# PROJECT PROGRESS REPORT

**PREPARED FOR THE ALASKA ENERGY AUTHORITY BY  
THE ALASKA CENTER FOR ENERGY AND POWER**

**PROJECT TITLE:** *Round 2: Emerging Energy Technology Fund – Data Collection*

**REPORTING PERIOD:** 2<sup>nd</sup> Quarter 2017

**DATE OF REPORT:** July 29, 2017

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## ***EETF Round 2 Projects***

### **Air Source Heat Pumps, CCHRC**

The air source heat pump project is complete, and no further data has been received. Final data analysis is in progress. ACEP has not received a final report.

### **Trans-Critical CO<sub>2</sub> Heat Pump, Alaska Sea Life Center**

The analysis period for the Alaska Sea Life Center trans-critical heat pump has ended, and the Alaska Sea Life Center has completed their final reporting. The CO<sub>2</sub> heat pumps were successful in generating high-temperature heat at efficiencies greater than those of an electric boiler. The data presented below represent the final reporting that ACEP will complete as part of this project.

Data were collected between April 12, 2016 and May 1, 2017. More recent data are also included in this report, although they were not part of the original data collection period. Trane, the heat pump company, experienced a database error from a shortage in memory which resulted in the loss of data from March 1<sup>st</sup> through April 12<sup>th</sup> 2017.

Data from three of the four heat pumps are shown below. Heat Pump 5 experienced a data collection error last spring and is not included in this report. Most data presented below are presented in terms of the coefficient of performance (COP). A COP is essentially a value of efficiency and is the ratio of the the heat energy produced by the system to the electric energy inputted into the system. Because a heat pump utilizes the phase change properties of a refrigerant at various pressures, efficiency values can be over 100%.

Over all, the heat pumps generated 194°F fluid with COP values of about 2. Details relating to the performance of the heat pumps are discussed in greater detail below.

### ***Sea Water Temperatures***

Resurrection Bay, from which the Alaska Sea Life Center draws the water that is used as the source of heat for the heat pumps, ranged in temperature from the upper 30's to the lower 50's. The histogram below shows the daily temperature of the raw sea water. In general the coolest temperatures occur in the spring while the warmest sea water temperatures in Resurrection Bay occur in the fall. The average sea water temperature was 45°F during the data collection period from April 12, 2016 until May 1, 2017.

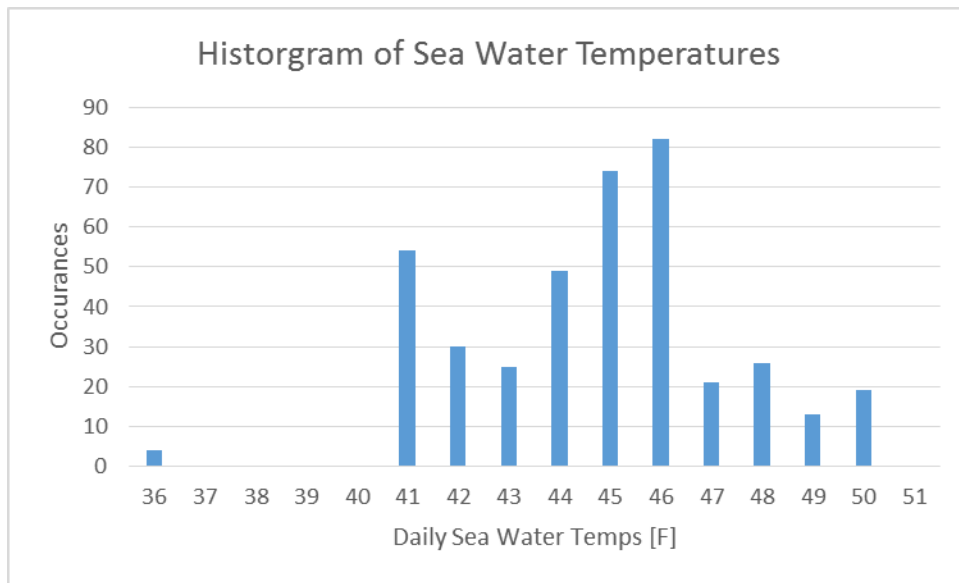


Figure 1: Histogram of sea water temperatures

#### *COP as a function of sea water temperatures*

As expected, the source temperature of the fluid from which the heat pump draws heat has a direct correlation on the system COP. One can observe in Figure 2 that, as the temperature of the sea water rises, so does the COP. It's important to note however that the sea water temperature is not the only factor that effects the system COP. This is discussed in the next section.

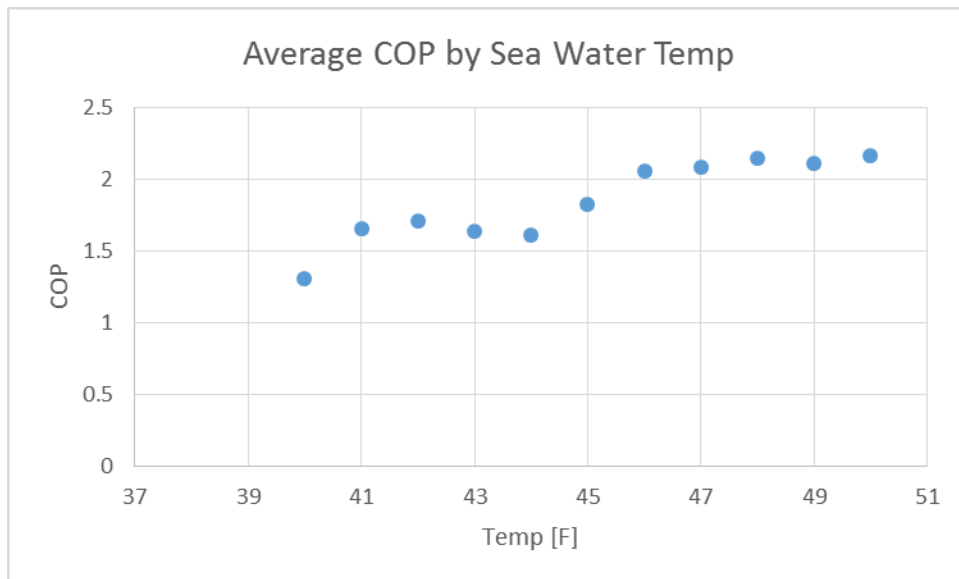


Figure 2: Average COP vs. sea water temperature

#### *COP vs. heat pump return temperature*

The data showed that the return temperature of the fluid entering the heat pump has a consistent influence on the system COP. The heat pumps are programmed to consistently heat a fluid to 194°F. The greater the difference in temperature between the fluid entering the heat pump and the fluid leaving the heat pump, the more efficiently the heat pump operates. Figure 3 illustrates concept. One can

observe that, when the heat pump lifts fluid from 90°F to 194 °F, it operates at a COP of about 2.5. When the heat pump lifts fluid from 140°F to 194°F, it then operates at a COP of closer to 1.5. The Alaska Sea Life Center is currently looking for additional heating loads where the heating loop can be utilized in order to better serve building loads and improve system performance.

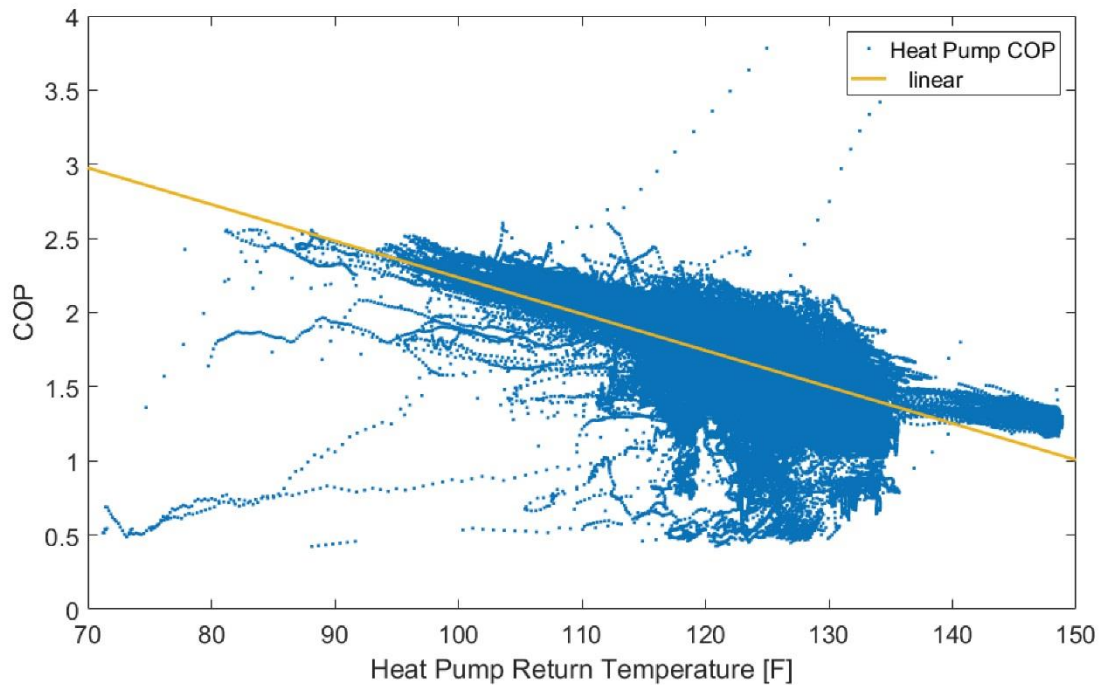


Figure 3: COP vs. heat pump return temperature

Figure 4 shows the average COP over the course of the entire data collection period. One can observe that in general COP values are between 1.5 and 2.5.

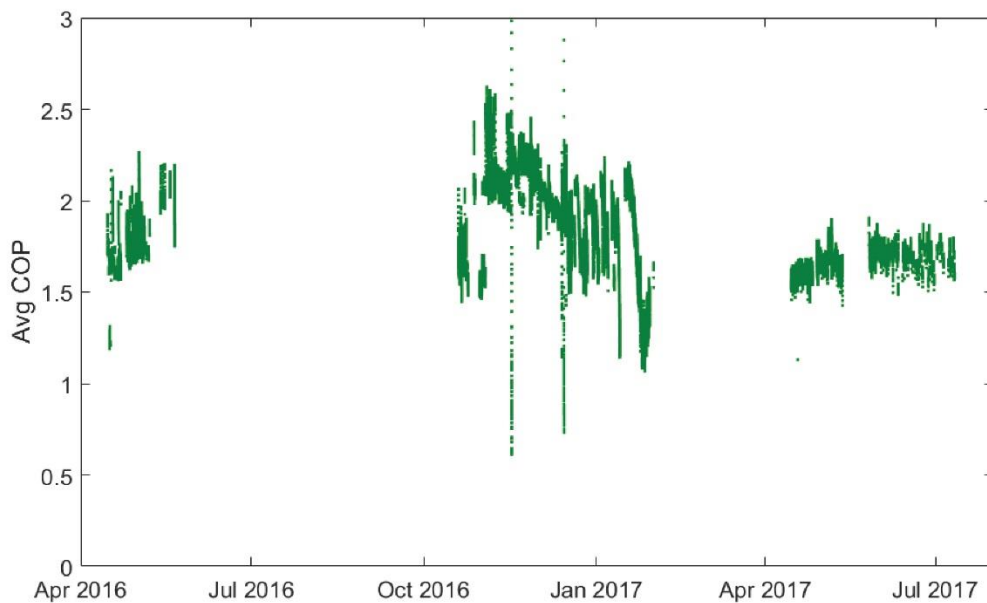


Figure 4: Average COP over duration of data collection period

Figures 1-4 show the general COP values of the heat pumps and the conditions at which the heat pumps operated at those COP's. The histograms below show the performance of the individual heat pumps. While the cop values vary slightly from heat pump to heat pump, in general all the heat pumps operate similarly.

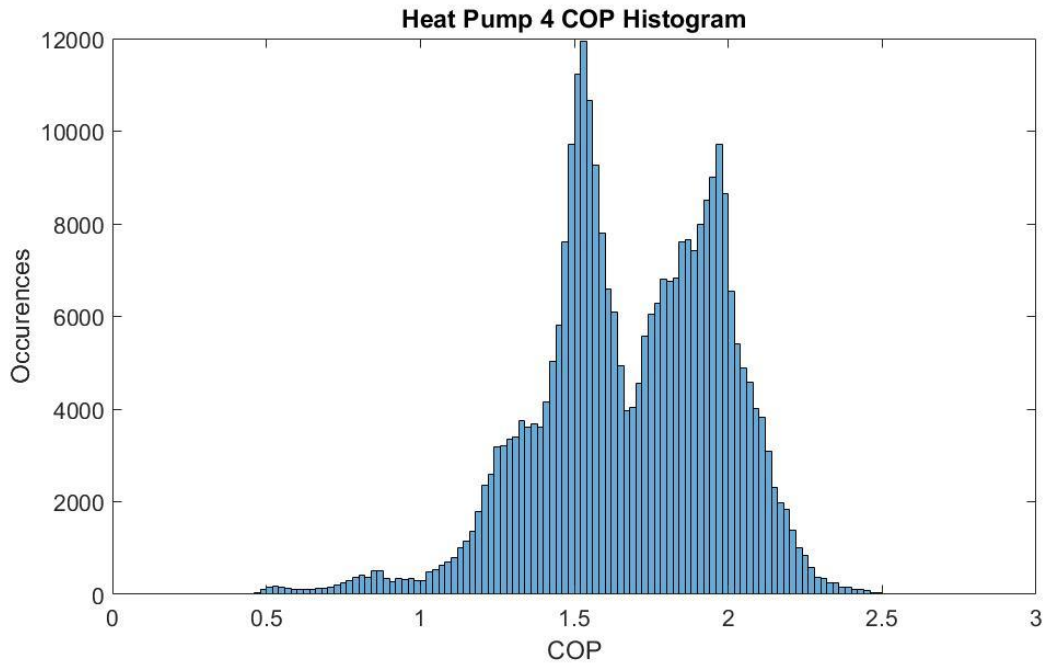


Figure 5: Heat Pump 4 COP histogram

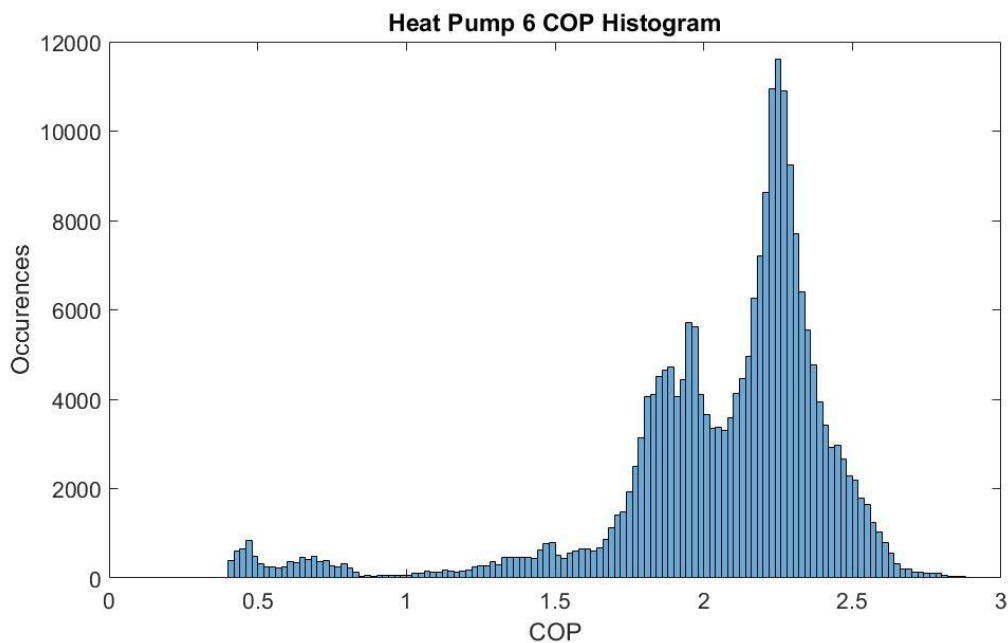


Figure 6: Heat Pump 6 COP histogram

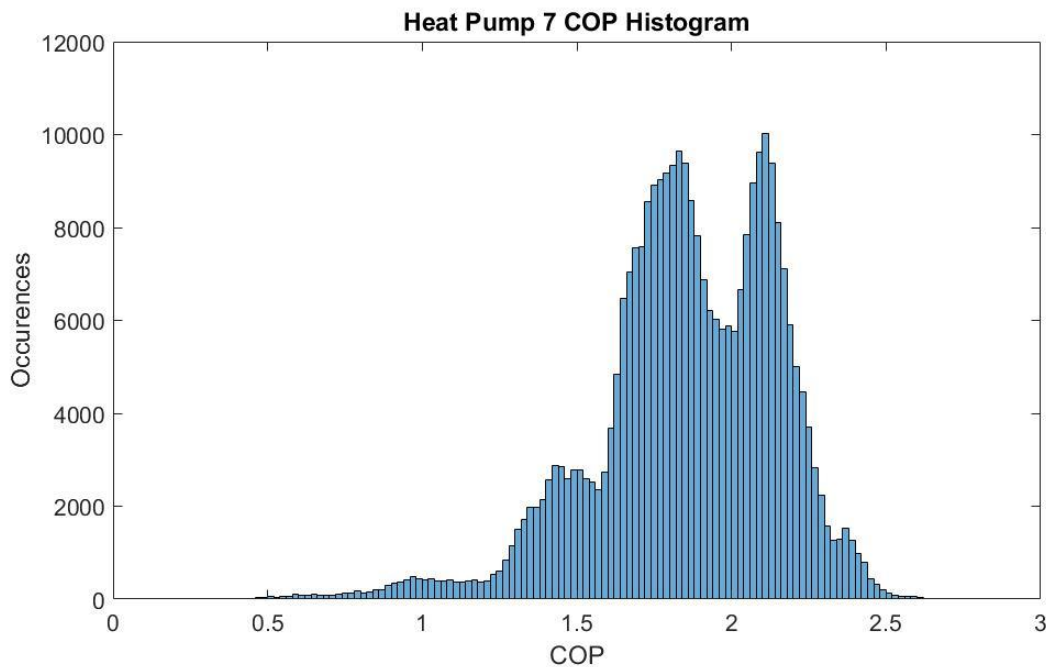


Figure 7: Heat Pump 7 COP Histogram

The heat pumps have a combined average COP of 1.9 during the study period. This equates to being nearly twice as efficient as an electric boiler. Since the Sea Life Center has made a commitment to minimize their carbon footprint and heat with only electricity except in emergencies, environmentally friendly CO<sub>2</sub> heat pumps appear to be a sound choice.

#### Multi-Stage Energy Storage System, Chugach Electric Association

The rescoped project construction is complete, and Chugach has connected both sides of the MESS (flywheel and battery) to the grid. Commissioning is presently finished, data collection and communication links have been tested, and testing is underway. ACEP will visit the project during the third quarter to gather additional informational and document progress.

#### St. Paul Flywheel Demonstration, TDX

This project has reached completion.